

Education Programs

Education programs at NREL advance precollege, undergraduate, graduate, post-doctoral and minority educational opportunities. The primary objective of NREL's education programs is to help ensure an adequate workforce to accomplish the nation's future energy research and development goals. These programs support national education policy goals outlined in "Goals 2000," the federal government's national initiative on education.

NREL and DOE believe it is important to cultivate and inspire a new generation of innovative scientists to discover and invent better ways of using our natural resources.

The NREL education program's key objectives are to:

- Use NREL's unique scientific facilities and staff to improve mathematics, science, energy, and technology education in the schools and the community
- Increase participation of women and underrepresented populations in math, science, engineering, and technology fields in education programs
- Improve science, mathematics, engineering, and technology literacy at all levels of education
- Increase the public's understanding of renewable energy and energy efficiency technologies
- Integrate educational efforts with those of other federal agencies, states, and the private sector to yield the greatest benefits for Colorado and the nation

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Community-based education relieves stress—in more ways than one

A recent Southern California Edison (SCE) project included off-grid photovoltaics (PV) as an alternative in an urban, upscale residential area to relieve stress on overburdened circuits. So, when an old underground circuit became overloaded because of home rebuilding and the installation of new or larger air conditioners, replacing it could have involved the expensive and disruptive tearing up of quiet neighborhood streets. Placing PV at the end of the circuit could indefinitely defer expensive circuit replacement.

In the process of implementing this project, SCE had to introduce the local community to this environmentally benign technology and to gain full community acceptance. SCE chose Monterey Hills Elementary School for the pilot site because it had a relatively large roof and was high enough to avoid shadowing or blocking anyone's view. But more importantly, it was a great place to start a community education effort.

NREL worked with DOE and SCE to educate both teachers and students, who became solar spokespeople for the project. After the Solar Neighborhood dedication ceremony at the elementary school, more than fifty parents and local residents volunteered their rooftops for PV installation. There are plans to expand this program to several other schools in southern California.

discover and invent better ways of using our natural resources. By strengthening education programs in science, mathematics, and technology, the Education Office at NREL is dedicated to the support of the system that produces future scientists and engineers.

What makes NREL's contributions to education so unique? One part of the answer lies in the unique talents and expertise of NREL's staff. Nearly 80% of NREL's research and support staff have degrees in science or engineering, and more than one-third have doctorate degrees. NREL research activities span several scientific and technical areas, encompassing dozens of specific disciplines.

Another part of the answer lies in NREL's facilities. With scores of laboratories, NREL's capabilities run from making sophisticated photovoltaic cells to analyzing molecular structures to genetically engineering enzymes.

The Laboratory has outdoor facilities for testing wind systems and PV arrays, a specialized building to test new building technology, and a high-flux solar furnace that uses concentrated solar energy to fashion space-age materials, destroy toxic wastes, clad steel, and produce ceramics. With this wealth of scientific and engineering resources to draw on, NREL is enriching mathematic, scientific, and technological education for teachers and students.

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Colorado Educational Activities

Colorado's population of 3.7 million is growing steadily. Of the students enrolled in Colorado schools from kindergarten through 12th grade, 21% are from minority families. NREL's programs will continue to provide minority populations and women with opportunities early in their education.

NREL has also been a key business partner in developing a statewide strategy...

NREL worked with the Colorado Governor's office on a 5-year, \$10 million project called CONNECT, which is funded by the National Science Foundation. The goals of CONNECT for Colorado students include having every K-

12 student reach significantly higher achievement levels in math and science; significantly reducing gender and ethnic differences in math and science achievement; and ensuring that students have the mathematical and scientific skills and knowledge they need to be successful in tomorrow's economy. NREL has also been a key business partner in developing a statewide strategy for CONNECT. In addition, NREL has updated the Laboratory's educational material to ensure that the content meets or exceeds the Colorado state content standards.

NREL continues to work with the Colorado Community Colleges and Occupational Education System, which was awarded a 5-year, \$24 million School-to-Career grant in 1995. The School-to-

Career initiative helps to build bridges between school and work. The vision of the state is to develop an integrated, standards-based educational system (K-adult), tied to economic development, that ensures through partnerships that all of its young people are prepared to excel in the competitive and dynamic global marketplace. The features of this program are designed to benefit all students as well as out-of-school youth; reinforce the need to prepare all students with high-level technical skills and related academic competencies leading to meaningful, high-quality employment and/or further education; expand the classroom to work sites in the community; advocate strong education-business partnerships; and expand and improve career and academic counseling in the elementary and secondary grades. To support this initiative, NREL sponsors the Expanding Your Horizons program, described below. High school and job shadowing internships will be offered as part of this initiative.

NREL's Visitors Center features various displays, interactive exhibits, and videos that explain how people can use renewable energy technologies in their homes, vehicles, and communities. The facility is visited by 6,500 people each year, including 1,500 Colorado school children.

Precollege Programs

NREL has extensive programs for precollege students, with more participants than NREL's other programs. One program that meets some of the goals of the School-to-Career initiative (see above) is Expanding Your Horizons, a national program supported by the Math/Science Network. The Math/Science Network is a non-profit membership organization of educators, scientists, mathematicians, parents, community leaders, and government and corporate representatives whose mission is to promote the continuing development of all people in mathematics and science, with particular emphasis on the needs of women and girls.

NREL is a key organizer of the Expanding Your Horizons program in Colorado.

The Expanding Your Horizons program introduces middle-school young women to successful female role models in hands-on workshop settings. The goal is to foster awareness of the career opportunities available for all young women, especially Hispanic, African American, Asian/Pacific Islander, and Native American females (grades 6-9) in math, science and nontraditional occupations. NREL is a key organizer in the state for this program, and several NREL women staff members have conducted Expanding Your Horizons workshops.

In addition, NREL sponsors and participates in a number of other programs and competitions aimed at students who want to explore career opportunities in mathematics, science, and technology. These include Frontiers of Science, the Colorado State Science Fair, the International Science and Engineering Fair, Junior Solar Sprint, Solar Bikerayce, Hands-On Science Outreach, Summer Science Adventures, and the Colorado and National Science Bowl.

NREL partners with the Colorado School of Mines and the University of Alaska for a 3-week math and science program for middle-school Native American students and teachers. Students and teachers complete a variety of renewable energy projects including building solar cars, solar ovens, and wind turbines.

NREL manages the National Junior Solar Sprint competitions for DOE. Junior Solar Sprint is an annual competition in which 7th and 8th grade students design, build, and race model cars powered by solar energy. Working in teams, the students are provided with kits

Junior Solar Sprint encourages 7th and 8th grade students to use math and science principles together with creativity in a fun, hands-on program.

that include only a motor and solar panel. The chassis, wheels, and transmission are made from any other materials. Students are encouraged to use math and science principles together with their creativity in a fun, hands-on educational program. For the 1996 national competition, there were 83 host sites in 36 participating states. In Colorado alone, there were 40 schools competing at NREL's Solar Energy Research Facility. The total participation in this program is 100,000 students and 15,000 teachers.

NREL has also participated in the last 4 years in an informal science education program that involves, students, parents, and communities. The Hands-On Science Outreach (HOSO) program

NREL/MRI's Summer Science Adventures program ... combines energy, conservation, and environmental activities.

looks at science in our everyday lives. It encourages K-5 students to observe the world by exploring and experiencing in a relaxed, playful, but guided framework. Applying science processes, the students play, experiment, observe, debate, and build models; they see that the application of science and

technology begins with simple materials, a need, and their minds. NREL has funded the program for six Denver-area elementary schools; other corporate sponsors, professional societies, and parent, teacher, or student organizations have funded other schools in the area.

From the 500 students participating in HOSO, thirty fourth- and fifth-grade students are chosen from the HOSO classes to participate in NREL's Summer Science Adventures program, funded by Midwest Research Institute (MRI). The program is a 5-day, residential live-in program that combines energy, conservation, and environmental activities. Students learn the important links between energy consumption and its impacts on the environment and explore technologies that can help solve some pollution problems. A sampling of activities include: a tour of a working mine, an aquatic field study, a challenge course, experiments involving the purification of water, observing the effects of ground and water pollution, constructing solar cars, and building electric circuit boards using PV cells.

The National Geographic Kid's Network is an innovative computer- and telecommunications- based science curriculum in which student scientists in grades 3 through 7 investigate new ideas and

exchange information with students around the world. Through the program, students learn real-world scientific procedures, engage in collaborative problem solving, expand their cultural, social, and environmental awareness, and enhance their computer skills.

NREL has partnered with the Kid's Network to provide a Solar Energy module to schools in Colorado and on Native American reservations. The past two summers, NREL has hosted Summer Institutes for teachers on solar energy, sponsored by DOE and the National

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Geographic Kid's Network. The summer institutes trained 30 teachers how to use the Solar Energy modules and to integrate science and mathematical themes across the curricula. During the course of the 5-day institute, participants learned about solar energy, conducted hands-on activities, gained computer skills to be used in telecommunicating data, and learned classroom management strategies for implementing the Kids Network program with their students. Summer Institutes are also held at Oak Ridge National Laboratory, Ames Laboratory, Los Alamos National Laboratory, and Princeton Plasma Physics Laboratory.

The National Teacher Enhancement Program (NTEP) is a collaborative effort of nine DOE national laboratories and the National Science Foundation (NSF) to improve the general level of K-12 science instruction. The program creates a cadre of lead teachers who serve as role models and mentors for their colleagues in systemic education reform initiatives. At NREL, the NTEP program is geared

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towards middle-level teachers. NTEP focuses on the way students learn about science by providing teachers with direct, hands-on experiences that involve problem solving in actual research settings. In order to translate this "real-world" scientific investigation into classroom learning, five key areas were

addressed throughout the program: curriculum, assessment, technology, diversity, and research. Each of these components is critical to the development of a teaching/learning instructional plan whereby students learn new material from a variety of perspectives.

In this program, teachers were partnered with NREL scientists for 40 hours of a laboratory science "immersion" experience. In addition, 80 hours of workshops, seminars, and field trips provided teachers with the tools necessary to translate their laboratory experiences into a classroom plan. Five follow-on days are scheduled throughout the school year to provide teachers with additional information on the five key areas and time to develop their classroom plans. Teachers receive three graduate credit hours through the Colorado School of Mines for attending this program. Teachers were also given an opportunity to apply for a follow-on grant of \$200 per participant to assist in the implementation of their classroom plans. The nine participating DOE laboratories will be submitting a joint NSF proposal for the continuation of this program.

Undergraduate, Graduate, and Postgraduate Programs

Through NREL's research divisions, the Laboratory has participated in undergraduate and graduate research programs by offering opportunities for students to spend research semesters or quarters at NREL while receiving academic credit for the experience.

NREL provides opportunities for underrepresented students through a number of collaborative programs. The Minority Access to Energy-Related Research Careers (MAERC) is a program for

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students that attend three California state universities and the University of Texas at Austin. The objectives of this program include increasing the number of well-prepared minority students pursuing advanced degrees in science and engineering, and increasing the number that will be interested in energy-related

research careers.

Students apply on a competitive basis for a MAERC appointment and begin in their junior year. They study and conduct research on campus during the academic year, then complete a 10-week research practicum during the summer at NREL or one of three other DOE laboratories. Students can renew their appointments in their senior year. Each year, up to 12 college-level junior and senior minority students are paired with NREL mentors to complete a research project.

NREL works with students and teachers at six Historically Black Colleges and Universities who perform solar radiation monitoring, and plans call for expanding the existing national network. The universities include Bethune-Cookman College, Bluefield State College, Elizabeth City State University, Mississippi Valley State University, South Carolina State College, and Savannah State College. With additional funding, this program will offer summer internships to the students who have participated in the solar radiation monitoring program.

Another DOE program involves students at North Carolina Agricultural and Technical State University. Called "An Undergraduate Engineering Option in Building Energy Conservation, Environmental Protection, and Economic Growth," this program involves 10 undergraduate and graduate students per year. The goal of the program is to develop a cadre of graduates who have, in addition to strong analytical capabilities, an in-depth knowledge of energy issues, a sensitivity toward environmental preservation, and an understanding of the economic factors that affect national energy programs and policies. In addition to departmental curricular requirements, and three senior/graduate-level courses developed specifically for this program, the students complete two on-the-job training phases.

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The first phase of the on-the-job training consists of a 10-week summer work assignment at DOE

in Washington, D.C. During this assignment, students also learn about DOE, its goals and management, and participate in field trips and seminars. The second training phase consists of a 12-month work assignment within DOE in Washington, at one of the national laboratories, or at a DOE regional office. NREL assists DOE in the recruitment of students; arranges 1-week practicums at different national laboratories including Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, and NREL; and arranges for research assignments for the students to complete their year-long work assignment.

DOE was a lead sponsor of Sunrayce 93 and Sunrayce 95, biennial intercollegiate competitions for solar-powered cars. General Motors Corporation and Electronic Data Systems have also been lead sponsors of these races. Highlights of Sunrayce 95 are summarized in the box.

The next Sunrayce will be held in June 1997. Sunrayce 97 will cross 1,980 km of America's heartland, from Indianapolis, Indiana, to Colorado Springs, Colorado. As in previous races, thousands of volunteers in academia and business will work together in a nonstop, collective learning-centered approach to furthering the development of ecologically responsible transportation alternatives.

Sunrayce 95 proves the mettle of students and solar energy

"Education, Energy, and the Environment" was the theme of this educational event designed to challenge science, math, and engineering students throughout North America, and to foster scientific innovation and creativity. The race took place June 20-29, 1995, and crossed America's heartland from Indianapolis to Golden, Colorado, home of the National Renewable Energy Laboratory.

Sunrayce 95 involved hundreds of students from 38 collegiate teams. The solar car projects allowed students—over a 2-year period of time—to apply classroom instruction while designing highly efficient, electrically powered vehicles that are fueled by a viable, renewable, and sustainable energy source—the sun.

Sunrayce helps DOE achieve its goal of developing scientists and engineers in critical energy fields by improving scientific and technological education in colleges and universities. Sunrayce 95 gave the students an opportunity for product development, creativity, and resourcefulness.

Community-Based Programs

Part of NREL's mission is to facilitate the commercialization of energy efficiency and renewable energy technologies. Community-based energy education programs promote the continued development and broad acceptance and implementation of these technologies. This mission is accomplished by creating partnerships, leveraging resources, and providing training and support.

NREL has worked on several community-based projects. Southern California Edison's Solar Neighborhood program is described in the box on page 3-1. In another program, the Nebraska Math and Science Initiative, Nebraska and NREL are developing a model to bring the scientific and

technical expertise residing at NREL into community settings. NREL wants to expand technology transfer and accelerate the commercial use of research by engaging students, teachers, and community leaders in using scientific research to solve community problems. The goals of the program are to encourage rural youth to explore scientific and technical careers; utilize knowledge and expertise at NREL to increase the use of renewable and energy efficiency technologies; reduce energy dependence and solve environmental problems in rural communities; and improve the teaching and learning of science by engaging students, teachers, and community leaders in problem-solving activities in partnership with scientists at NREL. This community model is being jointly developed between Nebraska and NREL and can be used as a tool for future projects.

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NREL's future education efforts will include innovative programs that reflect NREL's mission, DOE-mandated programs, and statewide partnership programs.

Education Technology

The United States and the world are now in the midst of economic and social change. Computers and information technologies are transforming nearly every aspect of American life. Continued success as a nation will depend on providing our students with the skills and knowledge necessary for high-technology work and informed citizenship.

Students must be afforded the opportunities provided by state-of-the-art educational technology.

This means that all students will have to achieve far more than they have been asked to in the past. They must be held to high standards that make clear what they should know and be able to do in the core academic subjects. And students must be afforded the

opportunities provided by state-of-the-art educational technology. Reaching the technology goals will ensure that technological literacy becomes the nation's new basic standard alongside reading, writing, and arithmetic.

Technology is a vehicle to change the way teachers teach and students learn. For the students, it provides access to real-world applications in mathematics and science. The ability to exchange large amounts of information at rapid rates allows students to transfer complex information and graphic representations of data. Interaction with people from other locales and cultures expands students' views and interests. For teachers, computer networks stretch their most scarce resource—time.

NREL participates in President Clinton's Technology Literacy Challenge, which envisions a 21st Century where all students are technologically literate. The first goal of this national program is that

all teachers in the nation will have the training and support they need to help students use computers and the information superhighway in their studies. Through several of its programs, NREL provides the opportunity for teachers to learn information technologies and the skills to be able to integrate these technologies into the classroom to increase student learning.

The second goal is that all teachers and students will have modern multimedia computers in their classrooms. NREL has worked to make computers accessible in local classrooms and provided software such as SIM City 2000, National Geographic Kids Network, the Junior

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Solar Sprint, Sun's Joules, and the Energy Doctor to increase students' learning opportunities. These programs are high quality, engaging, and directly relate to the science and math content standards and school curricula.

The third goal is that every classroom will be connected to the information superhighway. Connections to networks, especially the Internet, multiply the power and usefulness of computers as learning tools by putting the best libraries, museums, and other research and cultural resources at the students' and teachers' fingertips. Teachers need the ability to bounce ideas off peers and share experiences and resources with like-minded colleagues across the country. NREL has connected teachers electronically, allowing them to overcome the isolation they experience in their classrooms.

The fourth goal is that effective software and on-line learning resources will be an integral part of every school's curriculum. Computer software, video, distance learning courses, and on-line resources are expanding rapidly. These resources hold promise to improve learning, increase the amount of time students spend learning, and engage students in problem solving, research, and data analysis. To deliver on these goals, the President signed into law the Telecommunications Act of 1996, which ensures that schools and libraries have affordable access to advanced telecommunications service. The law requires telecommunications carriers to provide service to schools and libraries at reduced rates.

Locally, Colorado has a state plan called "A Vision for Technology in Colorado Education." This was released in 1995 and focuses on increasing the use of state-of-the-art technologies and developing staff. The goals

NREL's education programs will align with this state plan for technology in Colorado education.

relate to increasing integration of technology into instructional and administrative applications. The pre/K-12 and higher education communities are working together to design a statewide telecommunication network and grant program for "classroom technologies." The Colorado Public Utilities Commission and US West reached an agreement resulting in US West's allocation of over \$5 million for community-based telecommunication projects for pre/K-12, higher education, health

care, and libraries. Legislation was passed during the 1995 legislative sessions that allows local exchange carriers to provide discounted rates for interactive video applications for distance learning.

NREL's education programs will align with this state plan for technology in Colorado education, such as by ensuring that programs and educational information will be accessible over the Internet. NREL will partner with the Department of Energy, Department of Education, and other laboratories to expand the learning opportunities for both teachers and students by providing access to different programs offered at other labs electronically.